

Real-time hazard impact modelling for surface water flooding: some UK developments

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Session B1: Flood Hazard Mapping

1



2



3



4



What is the Natural Hazards Partnership?



Natural Hazards Partnership (NHP) Scope

- Resilience
- Natural Hazards including their **impact**
- Fast tracking world class science into services
- Timescales of 0-5 years
- UK and in those countries affecting UK citizens
- Governments and responder community
- Public good
- Non commercial
- **Hazard Impact Model: Surface Water Flooding**

Surface Water Flooding

- Surface Water Flooding (SWF)

- Major hazard with ~4 million properties at risk in England alone (EA, 2009)

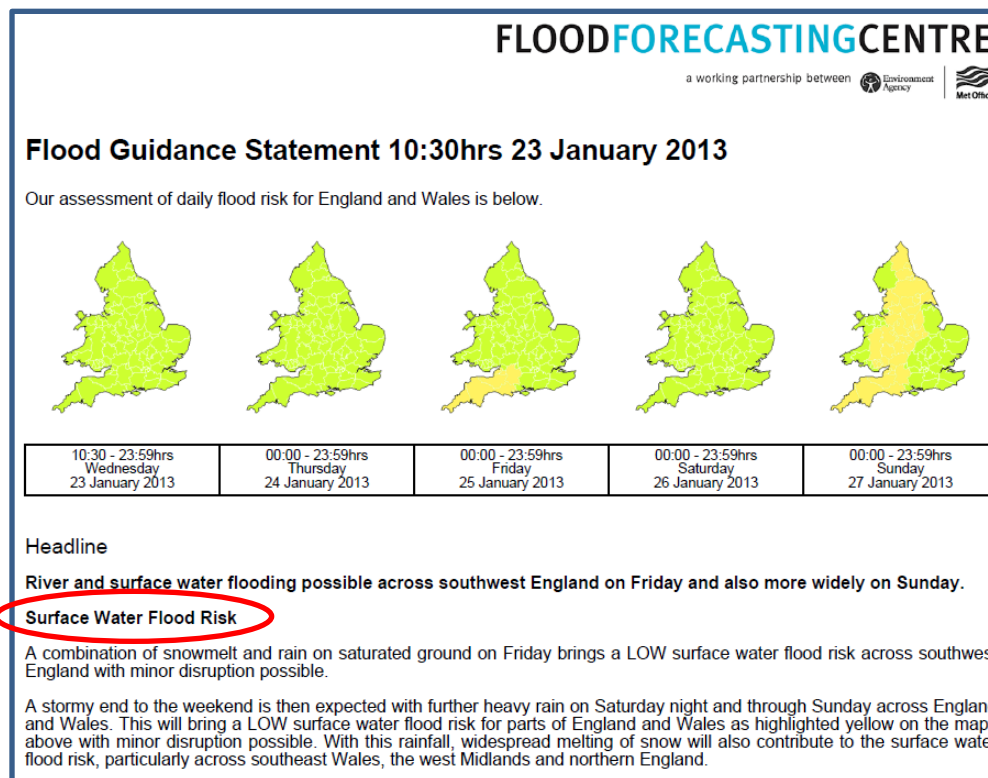
- Summer 2007 floods

- £3 billion insurance payouts
- 55,000 properties flooded, ~36,000 due to SWF
- National infrastructure impacts
 - 140,000 homes without clean water for 17 days
 - 42,000 homes without power for 24 hours
 - 10,000 people trapped on M5
- Pitt Review commissioned
- Flood Forecasting Centre & Scottish Flood Forecasting Service formed



Surface Water Flooding Alerts: Approaches

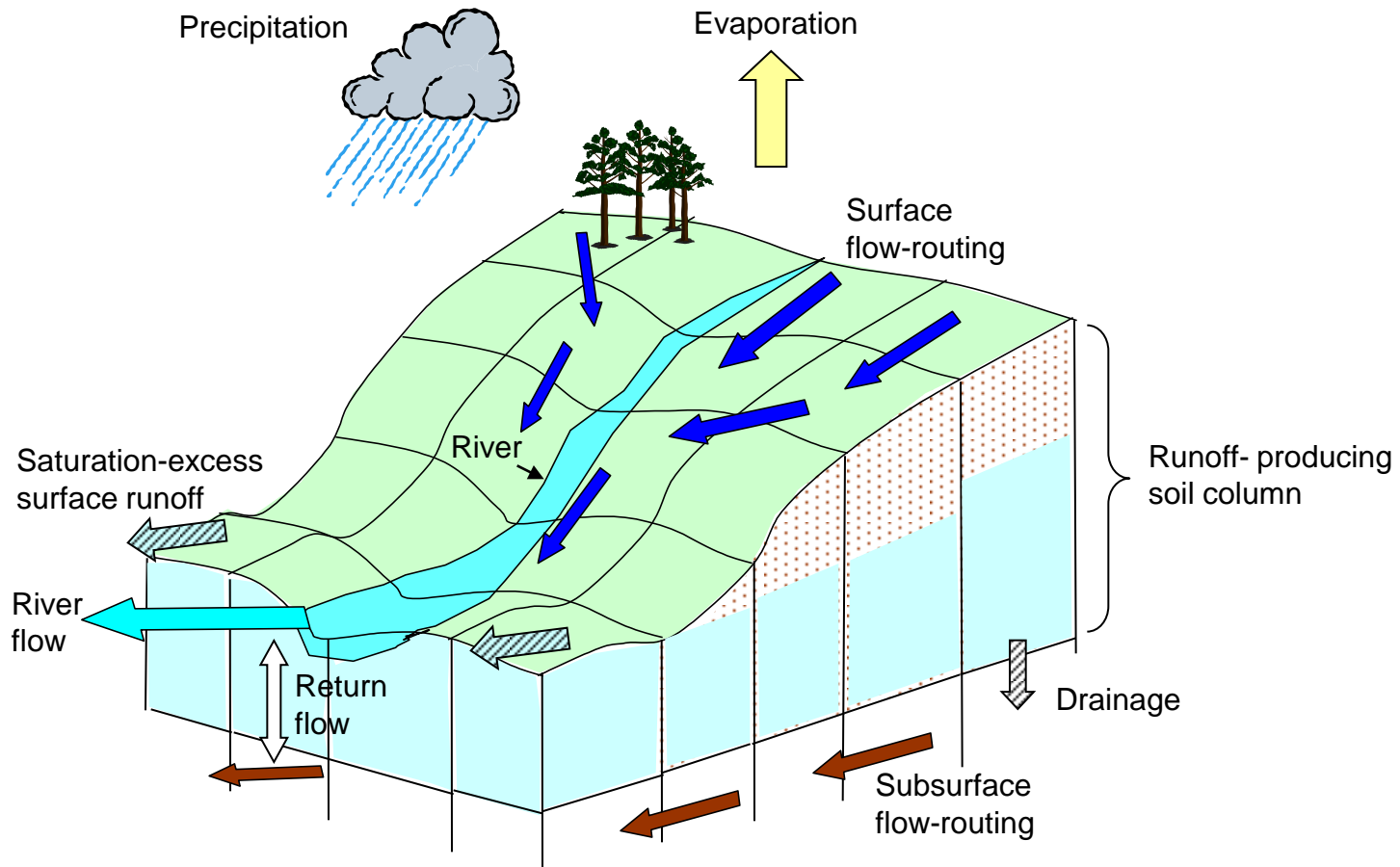
- Rainfall based alerts (current practice)
 - Extreme Rainfall Alert. Uses **national rainfall-thresholds**
 - Supports FFC **Surface Water Decision Support Tool** (Spreadsheet)
 - Feeds in to FFC daily **Flood Guidance Statement**



Surface Water Flooding Alerts: Approaches

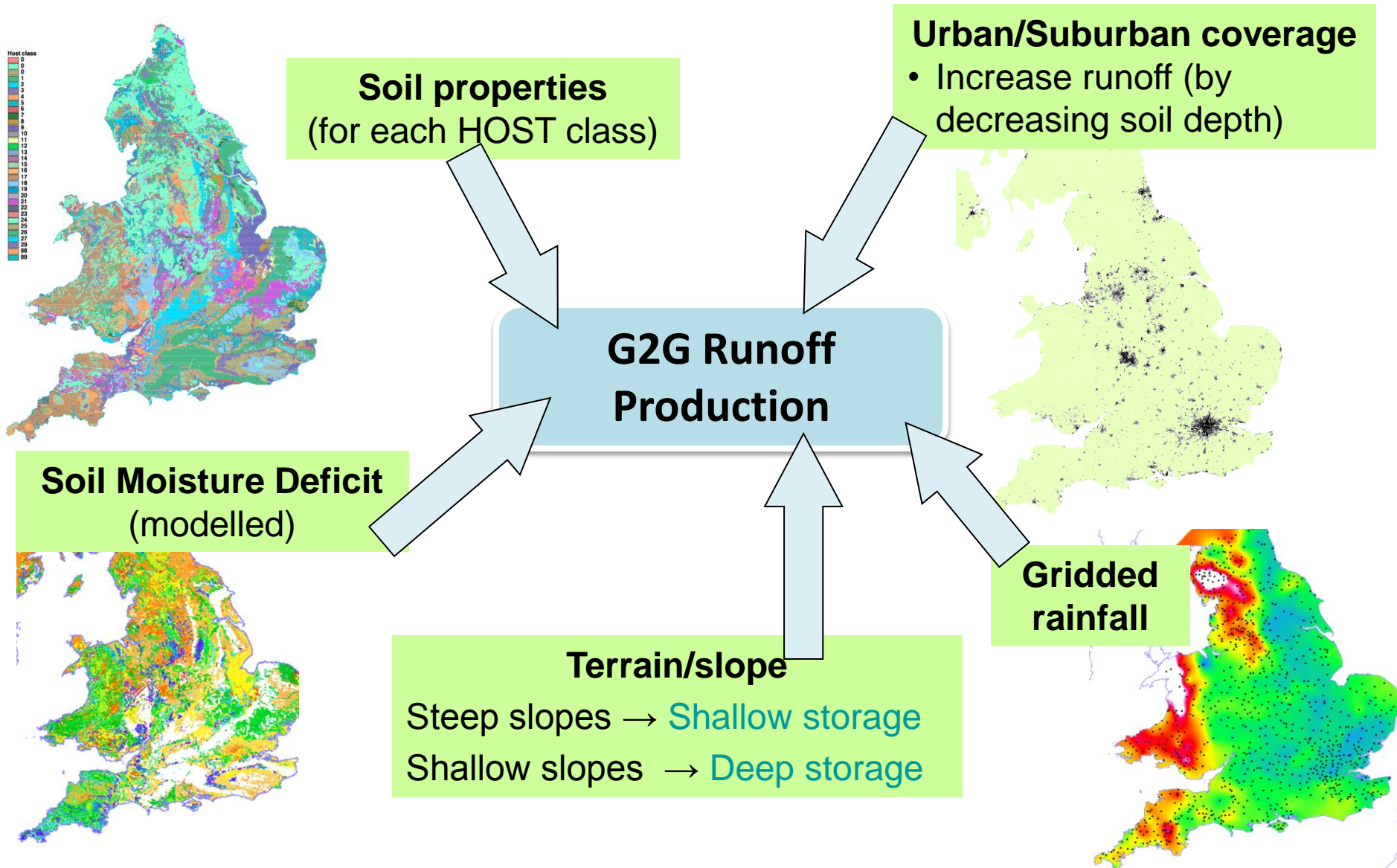
- Rainfall based alerts (current practice)
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 - Supports FFC Surface Water Decision Support Tool (Spreadsheet)
 - Feeds in to FFC daily Flood Guidance Statement
- Localised runoff thresholds (ongoing NHP developments)
 - G2G distributed hydrological model converts rainfall to runoff
 - G2G soil moisture conditions influence surface runoff production
 - Scientific advances to improve national SWF hazard footprint
 - G2G already used by FFC & SFFS so “quick win” potential
- New impact information (ongoing NHP developments)
 - Use national datasets on property, infrastructure & population
 - Potential for real-time hazard and impact forecasts

Grid-to-Grid (G2G) Distributed Model



- Uses spatial datasets on **terrain, soil/geology, land-cover**
- Responds to **spatial variation of rainfall input**
- Already **used countrywide** by **FFC** and **SFFS**

Factors affecting G2G runoff production

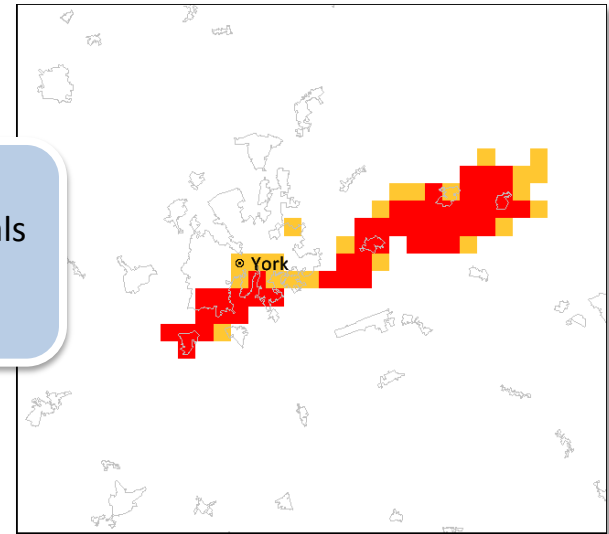


G2G runoff alerts for surface flooding

- Extreme Rainfall Alerts (ERA)
 - National rainfall-threshold based method
 - Based on FEH 30 year return period rainfalls “averaged” across 8 UK cities
- G2G runoff production affected by:
 - Rainfall amount **plus**
 - Urban/suburban coverage
 - Soil and geology properties
 - Antecedent soil moisture conditions
- Prototype runoff threshold exceedances seem **more targeted**

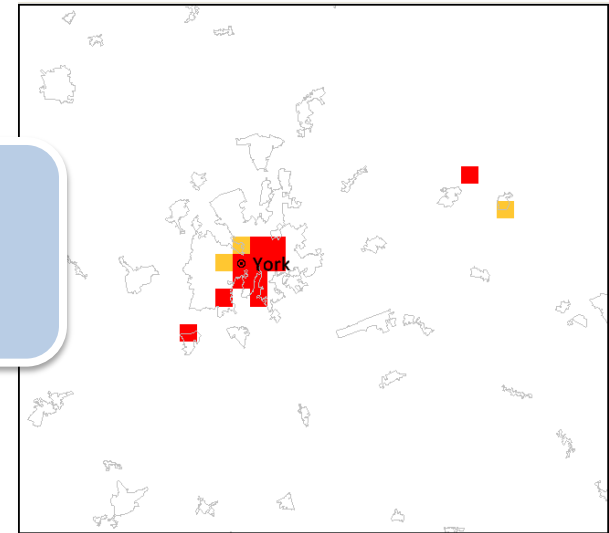
1h radar
rainfall totals

- >30mm
- >25mm



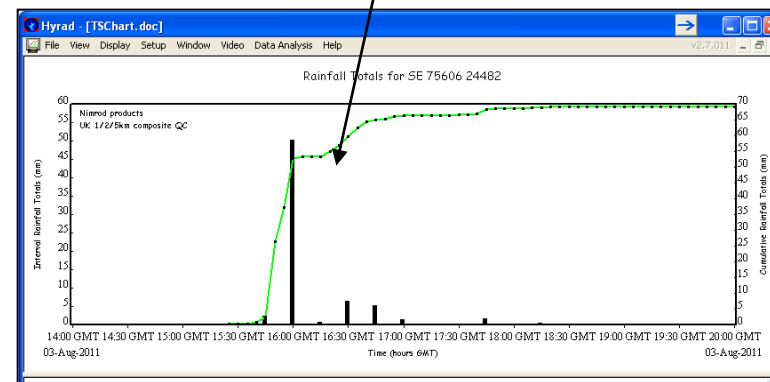
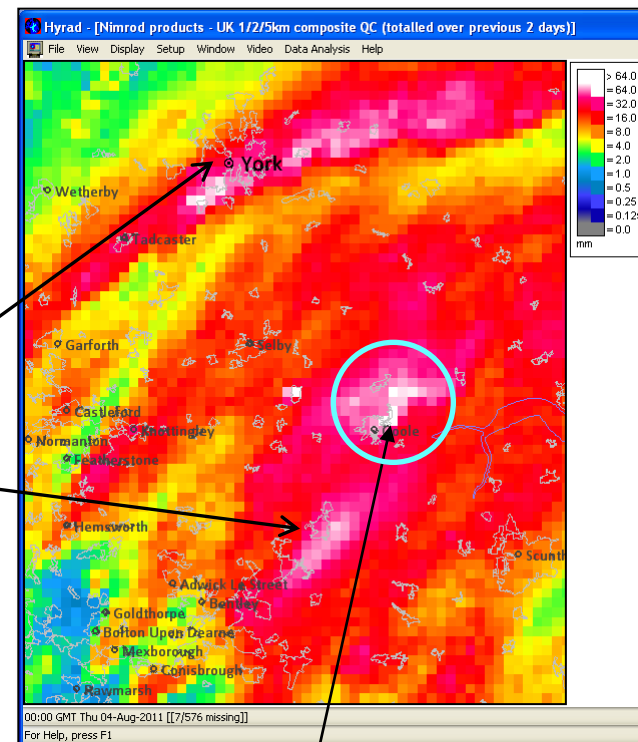
1h runoff
totals

- >8.5mm
- >7mm



SWF Case Study – 2-3 August 2011

- 2-3 August 2011 event
 - FFC identified event with **SWF impacts**
 - Peak radar accumulations of **40-60mm** near York and Goole
 - Reports of flooding at **Thorne** and **York**
 - **Goole** badly affected including a residential home
- End-to-end case study to produce **sample SWF impact maps**
 - Note uses radar-rainfall and not forecasts
 - Good first step, further development ongoing



SWF Case Study of 2-3 August 2011

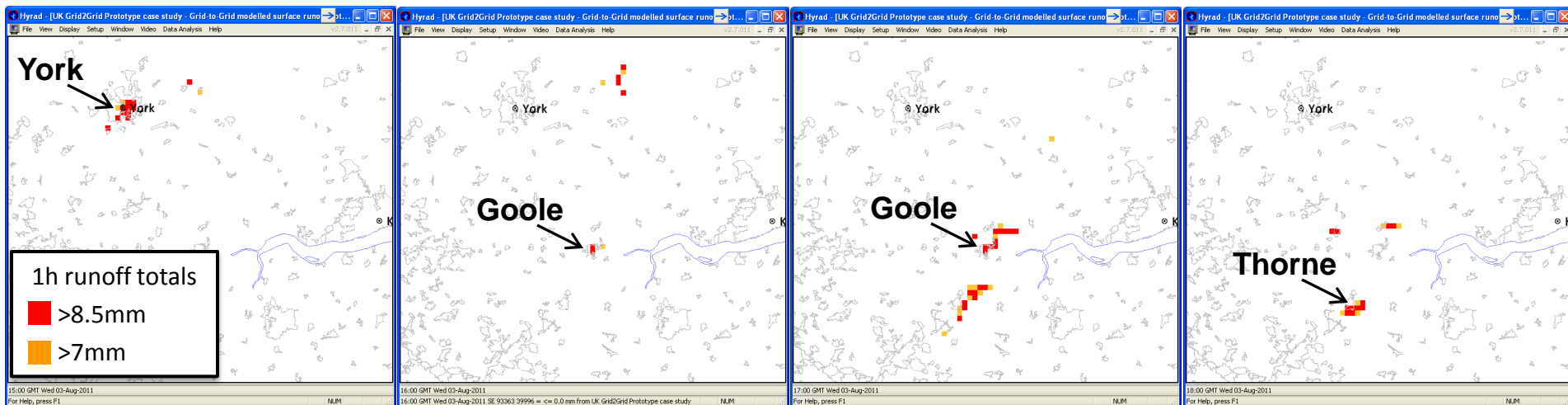
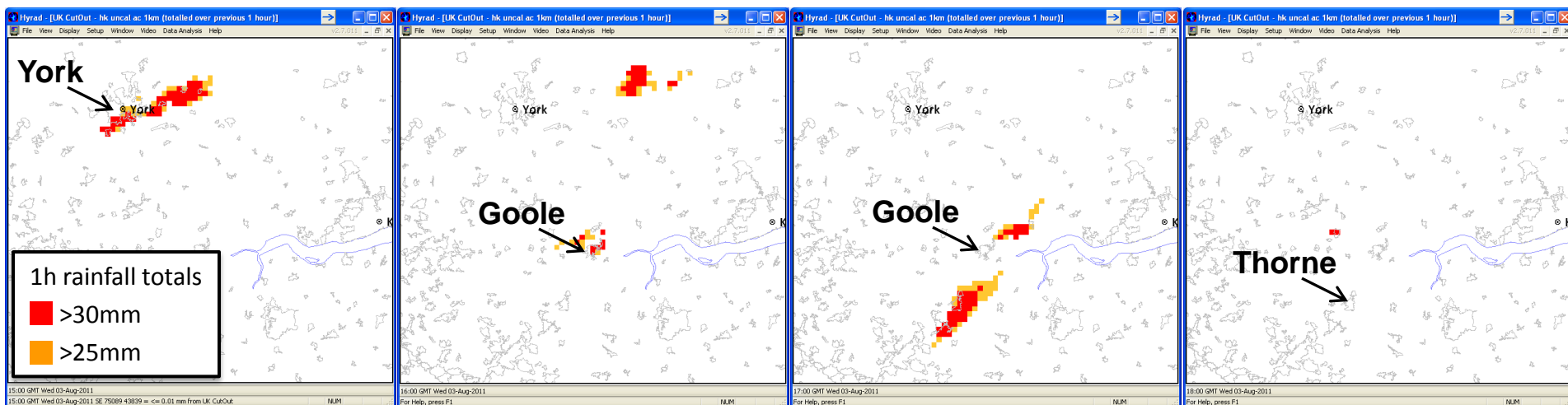
- Evolution of rainfall and surface-runoff accumulation maps
- Reported flood locations highlighted (FFC data)

15:00

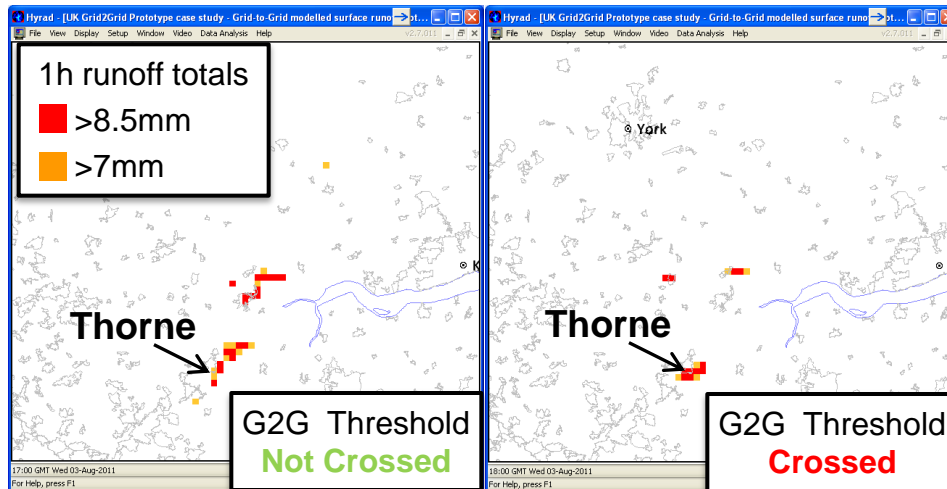
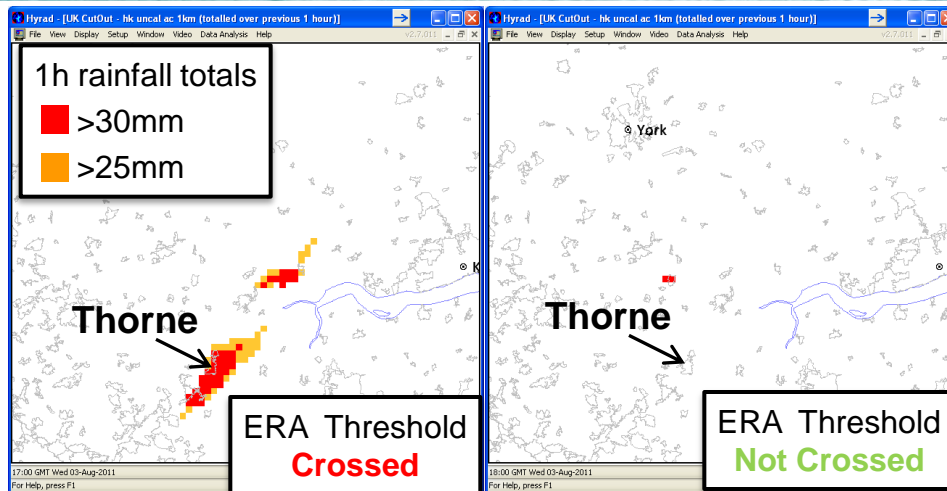
16:00

17:00

18:00



SWF Case Study: rainfall vs surface-runoff

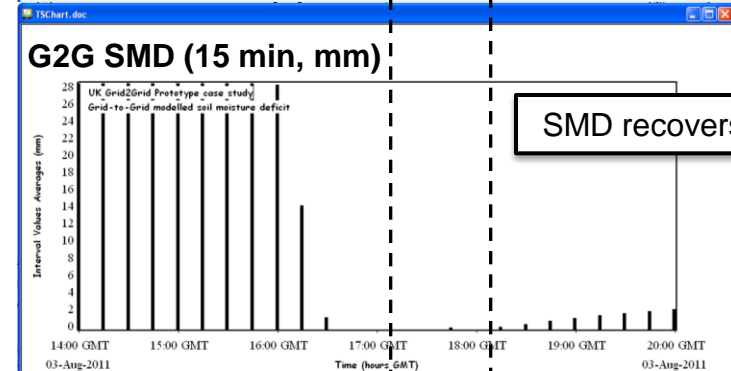
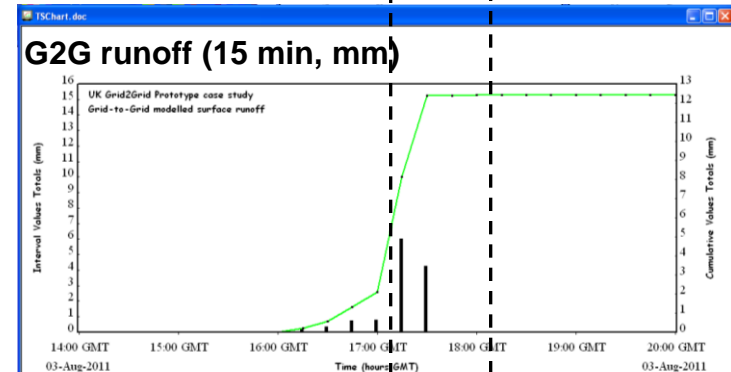
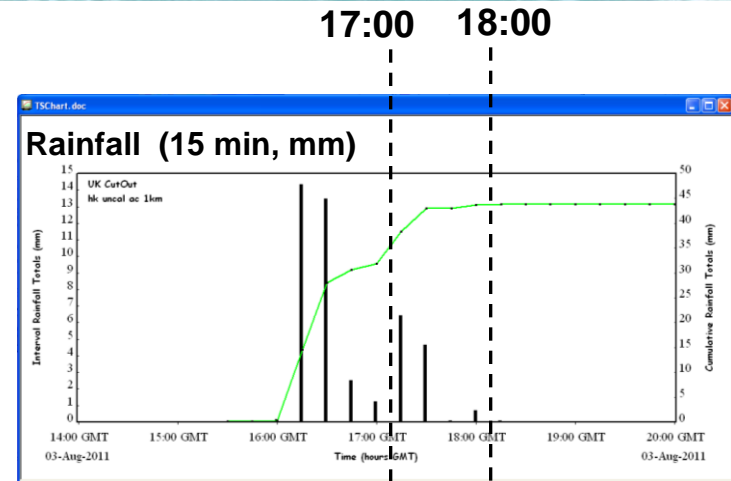


17:00

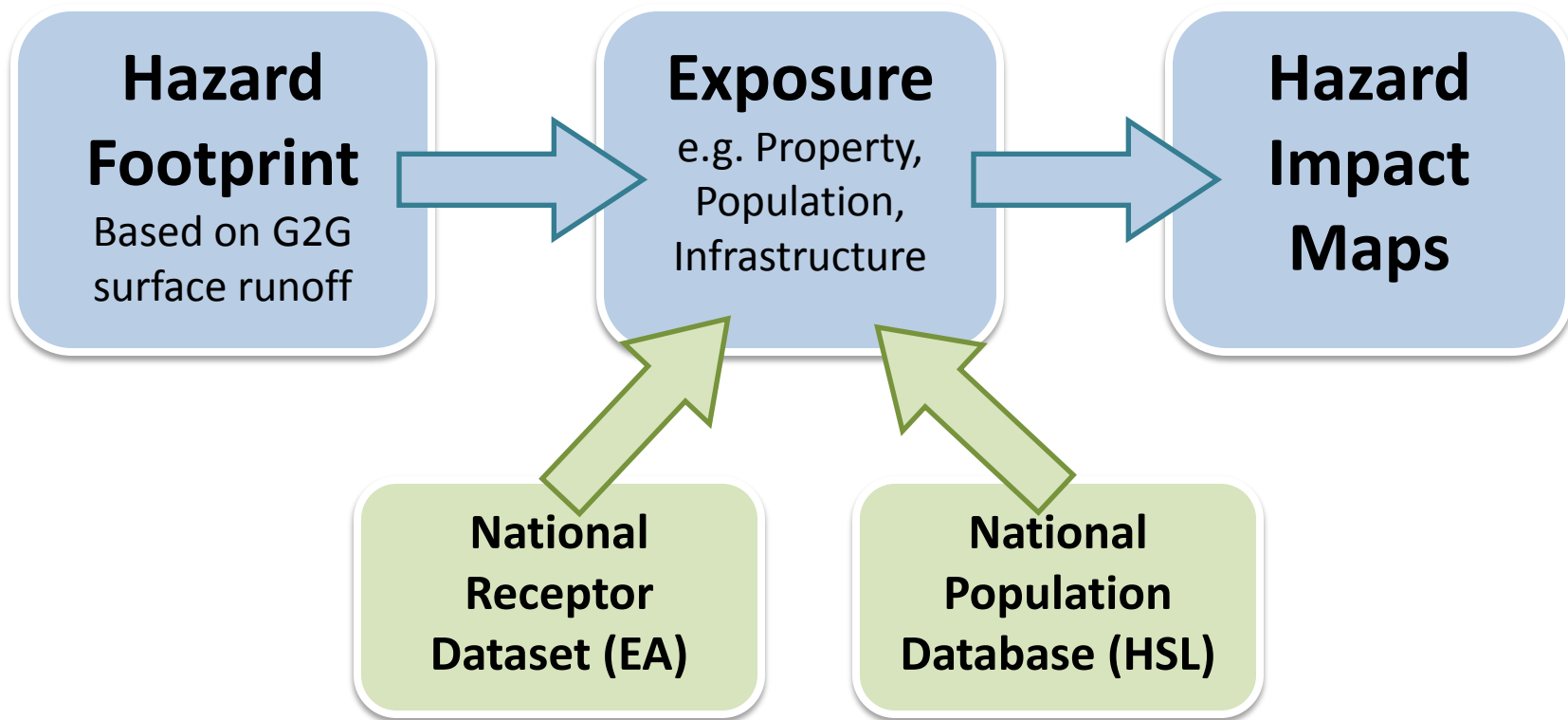
18:00

Heavy rain
 Low runoff %
 Pixel becomes saturated

Moderate rain
 High runoff %
 Saturated



Impact modelling approach



Hazard Footprint using G2G

- Prototype **G2G runoff thresholds** derived using a few case studies (similar to rainfall threshold approach)

Duration	1 h	3 h	6 h
Low G2G threshold	7 mm	13.5 mm	19 mm
High G2G threshold	8.5 mm	16 mm	23 mm

Key

- High Hazard
- Hazard

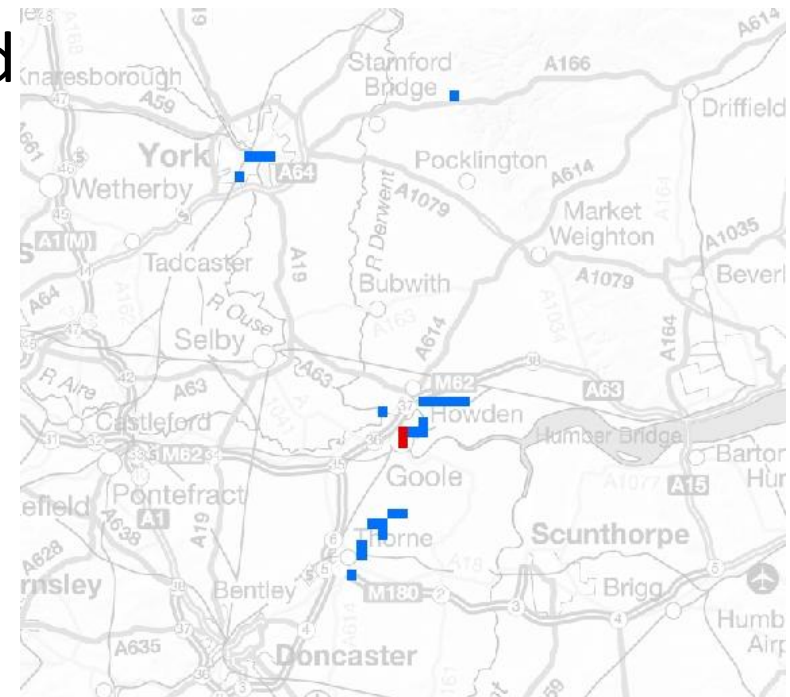
- Two types of footprint considered

- High-hazard footprint**

- Pixels where **all high thresholds** have been crossed

- Low-hazard footprint**

- Pixels where **any of the low thresholds** have been crossed

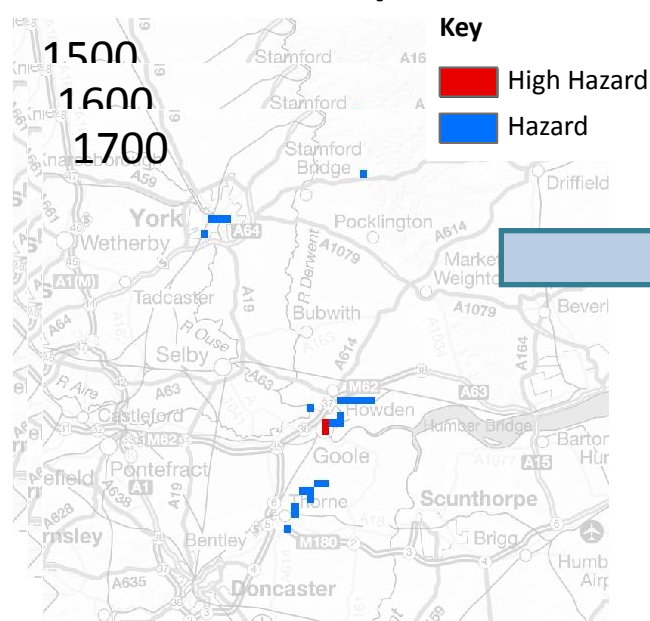


Dataset examples

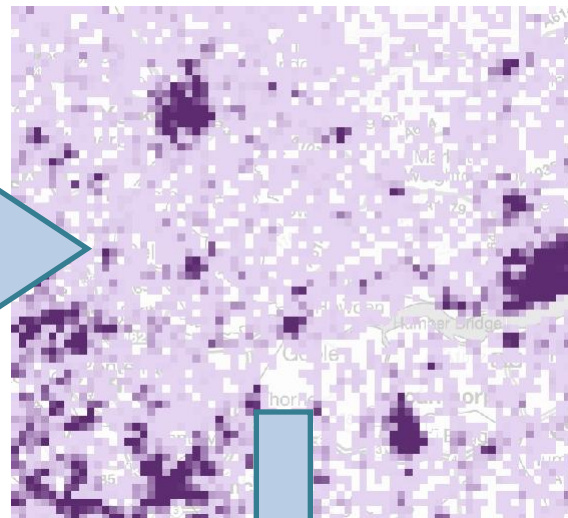
- **Day time population scenario (09:00-17:00)**
Residential day time term-time + Care homes + Hospitals + Schools + Prisons + Workplaces
- **Night time population scenario (17:00-09:00)**
Residential night time + Care homes + Hospitals + Prisons
- **Vulnerable population, as above except**
 - (i) residential population that are over 75 or long-term sick
 - (ii) workplace population removed
- **Vulnerable locations** (e.g. Schools and hospitals in NPD)
- **National Receptors Database**
 - (i) Housing (dwellings bulk class description)
 - (ii) Retail (Shop/Store and Retail bulk class descriptions)
 - (iii) Road and railway information from the Transport layer

Population impacts

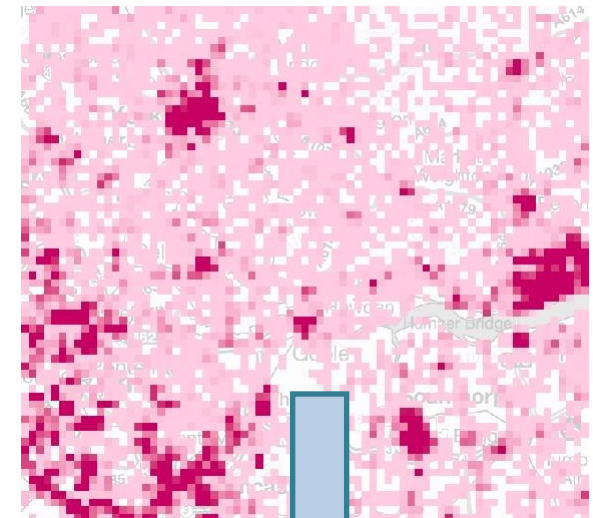
Hazard footprint



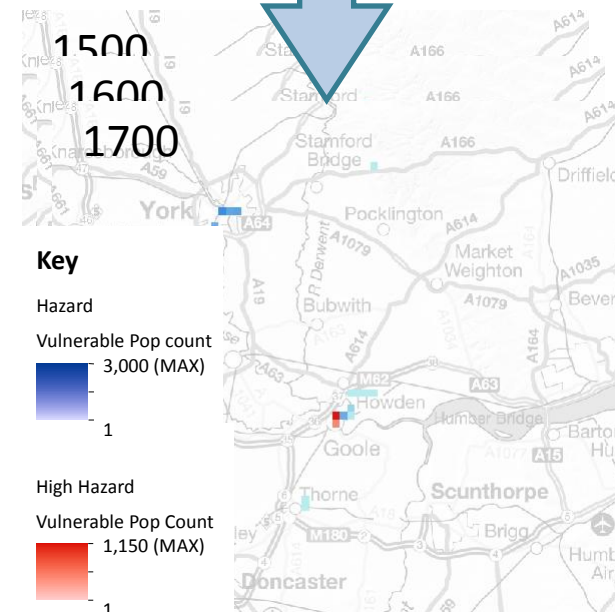
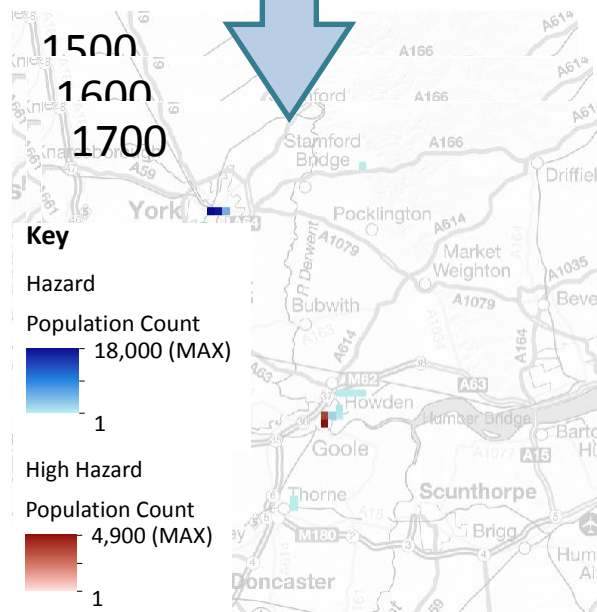
Population



Vulnerable Pop.

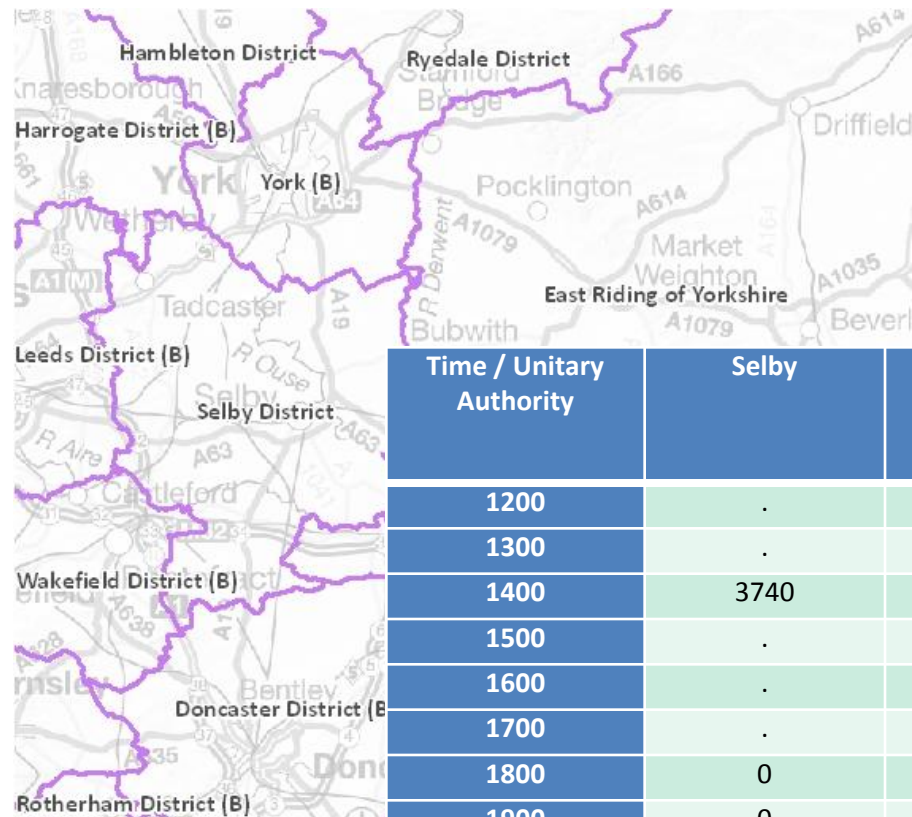


Hazard impact maps



Regional summaries

Unity authorities



Time / Unitary Authority	Selby	East Riding of Yorkshire	York	Doncaster	Ryedale
1200	.	.	.	.	.
1300	.	.	.	.	.
1400	3740	.	.	.	.
1500	.	.	68215	.	6
1600	.	8547	46344	.	4
1700	.	11328	41682	30	.
1800	0	4782	13735	3259	.
1900	0	13399	3259	2864	.
2000	0	9614	3259	.	.
2100	0	9614	.	.	.
2200	0	5	.	.	.
2300	0
0000



Centre for
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NATURAL ENVIRONMENT RESEARCH COUNCIL

•Note. '0' indicates the Local Authority has flooding, but no population expected. '.' indicates that no hazard was identified in the Local Authority.

Summaries over a time period

- Hazard footprint pooled over the timeframes of the event
- Summary of impacts in contiguous high hazard areas

Dringhouses (York)

At Risk Within High Hazard Area:

- 152 residential dwellings
- Home to 354 people

Vulnerable People

- 85 potentially requiring assistance

Vulnerable Locations

- none identified

Transport

- York-South Railway Line

Goole (peak 5pm)

At Risk within High Hazard Area:

- 3105 residential dwellings
- Home to 7211 people

Vulnerable People

- 1730 potentially requiring assistance

Vulnerable Locations

- Goole Hospital (82)
- 1 School (109)
- 2 Care homes (42)

Transport

- Goole to Hull Railway Line

Camblesforth / Brayton (peak 6pm)

At Risk within High Hazard Area:

- 0 dwellings affected

Infrastructure

- Drax Power Station

Hazard Rating



Next steps

- Targeted improvements to methodology
 - Runoff-production, vulnerability datasets, ...
- Use of latest Met Office rainfall forecast products
 - High-resolution **deterministic and probabilistic products**
- Mapping of surface water flooding impacts (with HSL)
 - Aim to move from **static to dynamic maps of hazard and impact**
 - Presentation of results, **local, regional and national**
- Further case studies and validation
 - Historical surface water flooding **data scarce and sporadic**
 - Link to other initiatives, e.g. **Hazard Impact Database** (KCL)
- Near-operational trial by FFC in 2014